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An enlisted rating composed of multiple skill communities may appear to be well-manned even though imbalances exist between its component communities. These imbalances may occur when the personnel requirements of one community are met at the expense of the complementary communities within the rating, as in the nuclear-trained and nonnuclear-trained portions of the electronics technician (ET) rating.

The imbalance problem within a rating could be overcome if the Navy had tools for managing communities at the skill level and at the rating level simultaneously. The feasibility of developing an inventory projection model for skill communities was evaluated by examining the specific case of nuclear skilled communities within the ET, machinist's mate, and electrician's mate ratings.

Criteria were established for identifying nuclear community members from the data on their survival tracking file records. All past personnel movement into and through the nuclear communities was found to be measurable. These findings enabled longitudinal cohort trackings of FY78, 79, 80, and 81 entering year groups. The stability of the personnel flow rates observed between cohorts supports the feasibility of developing an inventory projection model for nuclear skilled communities.

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THE FEASIBILITY OF MODELING SKILL SPECIALITIES: THE CASE OF NUCLEAR TRAINED PERSONNEL

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AND
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THE FEASIBILITY OF MODELING SKILL SPECIALITIES: THE CASE OF NUCLEAR TRAINED PERSONNEL

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FOREWORD

This exploratory development was conducted in response to Navy Decision Coordinating Paper ZF63-521-01-010 (Manpower and Personnel Technology), subproject 03.16 (Accession Planning Models). The objective of this effort was to determine the feasibility of modeling enlisted skill communities for inventory projection purposes by examining the case of nuclear skilled communities in three ratings. This report presents analyses conducted to assess data adequacy and to evaluate the stability of nuclear community characteristics over time. The findings support the feasibility of modeling nuclear communities. The approach outlined may be used to evaluate modeling feasibility for other skill communities.

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SUMMARY

Problem

Occupational specialties within enlisted ratings are assigned unique Navy enlisted classifications (NECs). At any particular time, the occupational mix of NECs required by the Navy may not match the occupational mix of available personnel. When this imbalance occurs, a billet designated for a specific NEC may be filled instead by someone who holds a related NEC within the same rating (or sometimes, in a different rating). However, in closed-loop NECs, no substitution is permitted. A billet designated for a closed-loop NEC may be filled only by persons possessing the specific NEC.

If a rating is composed of both types of communities, the non-closed-loop community may suffer personnel shortages at the expense of the closed-loop community. This problem arises because the Navy currently manages its personnel inventory at the rating level of aggregation, with exceptions made for a few closed-loop communities. When the needs of the closed-loop communities are met first, shortages that occur in the rest of a rating may not be detected because the overall rating appears to be well-manned.

This imbalance could be overcome if the Navy had techniques to manage skill communities at both the NEC level and the rating level. An inventory projection model that operates at the NEC level could be a primary tool for skill management.

Objective

The objective of this research was to determine the feasibility of developing an inventory projection model for NEC communities by examining the specific case of nuclear skill communities within the electronics technician (ET), machinist's mate (MM), and electrician's mate (EM) ratings.

Approach and Results

The investigation into nuclear skill communities was conducted in three phases, each of which explored past enlisted force data to determine the types of analyses possible at the NEC level of aggregation. In Phase 1, reliable criteria for identifying nuclear community members were determined, and the statistical characteristics of nuclear communities at periodic intervals were derived. Phase 2 established that all past personnel flows into and through the nuclear communities were measurable and suggested a cohort definition for use in Phase 3, in which longitudinal cohort trackings were performed. The stability of the cohort flow rates in the past was then evaluated to assess the feasibility of an inventory projection model. The longitudinal trackings revealed that the personnel flow rates were similar across the cohorts.

Conclusions

The results of this investigation support the feasibility of modeling nuclear communities within the ET, MM, and EM ratings. The capabilities to identify community members and to quantify personnel flows established by this effort enabled the design of a longitudinal cohort analysis. The stability of the personnel flow behavior exhibited between cohorts supports the feasibility of modeling NEC communities. However, the modeling of any NEC community depends on two factors: (1) the adequacy of data sources and, given that, (2) the stability of flow rates. The lack of these factors for other NEC communities may preclude model development.

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INTRODUCTION

Background and Problem

The Navy's skilled enlisted force contains approximately 95 ratings or occupational fields, with various areas of specialization. A person who gains proficiency in one of these specialties by completing the requisite training is credited with the appropriate Navy enlisted classification (NEC). Personnel who hold a specific NEC within a rating collectively represent a skill community within that rating.[1] A person may earn more than one NEC in a rating, making him or her a resource for multiple positions or billets.

At any particular time, the occupational mix of NECs required by the Navy may not match the inventory of personnel available. When this imbalance occurs, a billet designated for a specific NEC may be filled by someone who holds instead a related NEC within the same rating (or sometimes, in a different rating). However, in "closed-loop NECs," no substitution is permitted. The highly technical or specialized nature of the skills represented by closed-loop communities require that their billets be filled only by personnel with a specific NEC. Among the approximately 135 closed-loop communities in the enlisted force are nuclear-trained personnel within the electronics technician (ET), machinist's mate (MM), and electrician's mate (EM) ratings; medical and dental specialties within the hospital corpsman and dental technician ratings; and the diver specialty, which cuts across numerous ratings.

A closed-loop community poses managerial problems for the enlisted community manager (ECM) responsible for the rating containing it; due to the lack of substitutability that characterizes closed-loop communities, it is particularly difficult to keep billets filled with personnel of the requisite skills. If the rating contains both a closed-loop community and the regular rating population, the latter may suffer personnel shortages at the expense of the closed-loop community. This problem arises because the Navy manages its personnel inventory at the rating level of aggregation. As a result, a rating as a whole may appear well-manned while masking serious shortages among its component parts. This imbalance could be reduced if the Navy had the techniques to manage skill communities at both the NEC level and the rating level. An inventory projection model that operates at the NEC level could be a primary tool for skill management.

Objective

The objective of this research was to investigate the feasibility of developing inventory projection models for NEC specialties by exploring the case of a specific closed-loop community.

APPROACH AND RESULTS

Nuclear communities within the ET, MM, and EM ratings were selected for this research because they represent a high training investment, and because ECMs expressed an immediate need for the modeling capability to simultaneously meet the personnel requirements of the nuclear (closed-loop) and nonnuclear components of their ratings.

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[1]For purposes of this report, the terms NEC, specialty, and skill community are used interchangeably to designate skill specializations that are subsets of one or more ratings.

A three-phase investigation of these nuclear skill communities was conducted to determine whether (1) nuclear community personnel were identifiable, (2) personnel movement into and through the community was measurable, and (3) the flow rates were sufficiently stable to support an inventory projection model. The survival tracking file (STF),[2] which contains quarterly "snapshots" of each member of the enlisted force since the fourth quarter of FY77, was the source of data. A description of the three research phases follows.

Phase 1: Identifying Nuclear Community Members

The primary objective of Phase 1 was to determine reliable criteria for identifying nuclear community members, in a data processing sense, and for discriminating between pipeline and cadre membership.[3] The criteria were then used to produce a variety of statistical summaries of the nuclear community.

Two NEC fields were available on the STF records--primary NEC (PNEC) and secondary NEC (SNEC)--for possible use in identifying nuclear community members. PNECs 3351-3399 are reserved for nuclear-skilled individuals; SNEC 9901 indicates nuclear pipeline membership. To test the accuracy of these data fields, the STF was used to derive counts of individuals having SNEC 9901 and PNECs 3351-3399 as of the end of fiscal years 78-81. These results were then compared to past inventories maintained by the nuclear ECM. Because the two sets of counts basically agreed, the SNEC and PNEC fields were accepted as reliable indicators of nuclear community membership. Moreover, the STF records were checked to ensure that no individual simultaneously had SNEC 9901 and PNEC 3351-3399, and thus, that the SNEC and PNEC could accurately discriminate between pipeline and cadre members.

The SNEC and PNEC data fields were then used to derive a variety of descriptive statistical information about nuclear communities. As shown in Table 1, significant numbers of personnel are engaged in nuclear training and the distribution of the nuclear pipeline over ratings has stayed relatively consistent over time. In general, the proportion of nuclear pipeline personnel associated with ratings other than apprenticeships has declined. The total nuclear cadre has grown from 10,218 to 11,430, but the rating distribution has remained stable.

In all years from 1978-81, there were a negligible number of E1-3 nuclear pipeline personnel who were not apprentices, suggesting that they do not become designated for these ratings until they are advanced to E4 (see Table 2). The results presented in Table 2 suggest that most of the members who complete the pipeline, and thereby enter the cadre, do so near the time they are advanced from E4 to E5. Specifically, the percentage of cadre members who were E4s ranged from 10.3 to 15.4 over the 4 years studied, and the percentage of nuclear pipeline members who were E5-9 ranged from 1.8 to 5.5 during the same period. The small number of nuclear cadre members who were E1-3 (< 1.05%)

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[2]Borack, J.I., & Gay, K.W. (April 1981). The enlisted survival tracking file (STF). (NPRDC Tech. Note 81-11). San Diego: Navy Personnel Research and Development Center.

[3]The following definitions are used in this report: "Nuclear pipeline" refers to any personnel in training that will earn a nuclear NEC; "nuclear cadre" refers to anyone possessing a nuclear NEC; "nuclear community" refers to the nuclear pipeline and nuclear cadre combined.

Table 1

Distribution of Nuclear Pipeline and Cadre Members Across Ratings and Apprenticeships, FY 78-81

Rating	End Fiscal Year 78	79	80	81
Pipeline				
Electronics technician (ET)	1,191[a] (16.7)[b]	1,035 (15.3)	1,031 (14.5)	1,097 (13.6)
Machinist's mate (MM)	2,309 (32.3)	2,202 (32.6)	2,007 (28.1)	2,391 (29.6)
Electrician's mate (EM)[c]	1,244 (17.4)	1,194 (17.7)	1,143 (16.0)	1,362 (16.8)
Apprenticeships	2,389 (33.5)	2,316 (34.2)	2,942 (41.3)	3,235 (40.0)
Others	5 (0.1)	17 (0.2)	7 (0.1)	4 (0.0)[d]
Total	7,138 (100.0)	6,764 (100.0)	7,130 (100.0)	8,089 (100.0)
Cadre				
Electronics technician (ET)	2,141 (21.0)	2,343 (21.1)	2,386 (21.1)	2,428 (21.2)
Machinist's mate (MM)	5,054 (49.4)	5,539 (49.9)	5,751 (50.8)	5,705 (49.9)
Electrician's mate (EM)	3,001 (29.4)	3,207 (28.9)	3,161 (28.0)	3,289 (28.8)
Others	22 (0.2)	15 (0.1)	11 (0.1)	8 (0.1)
Total	10,218 (100.0)	11,104 (100.0)	11,309 (100.0)	11,430 (100.0)

[a]Frequency.

[b]Percentage.

[c]The EM and interior communications (IC) ratings were combined because IC was discontinued as a nuclear field during the period covered by this analysis.

[d]<0.05%.

Table 2

Distribution of Nuclear Personnel Across Pay Grades and Rated Status, FY 78-81

End Fiscal Year	Pay Grade: E-1 to E-3 Apprentice	E-1 to E-3 Rated	E-4 Apprentice	E-4 Rated	E-5 to E-9 Apprentice	E-5 to E-9 Rated	Total Apprentice	Total Rated
Pipeline								
78	2,389 (33.5)	43 (0.6)	0 (0.0)	4,307 (60.4)	0 (0.0)	392 (5.5)	2,389 (33.5)	4,742 (66.5)
79	2,316 (34.3)	53 (0.8)	0 (0.0)	4,260 (63.1)	0 (0.0)	118 (1.8)	2,316 (34.3)	4,313 (65.7)
80	2,942 (41.3)	73 (1.0)	0 (0.0)	3,969 (55.7)	0 (0.0)	139 (2.0)	2,942 (41.3)	4,189 (58.7)
81	3,235 (40.0)	85 (1.1)	0 (0.0)	4,539 (56.1)	0 (0.0)	226 (2.8)	3,235 (40.0)	4,850 (60.0)
Cadre								
78	0 (0.0)	26 (0.3)	0 (0.0)	1,055 (10.3)	0 (0.0)	9,141 (89.4)	0 (0.0)	10,222 (100.0)
79	1 (0.0)[a]	59 (0.5)	0 (0.0)	1,722 (15.4)	0 (0.0)	9,367 (84.0)	1 (0.0)[a]	11,148 (100.0)
80	0 (0.0)	34 (0.3)	0 (0.0)	1,692 (14.9)	0 (0.0)	9,606 (84.8)	0 (0.0)	11,332 (100.0)
81	2 (0.0)[a]	49 (0.4)	0 (0.0)	1,479 (12.9)	0 (0.0)	9,943 (86.7)	2 (0.0)[a]	11,471 (100.0)

[a]Percentage less than 0.05.

were assumed to have been demoted for disciplinary reasons after they had achieved cadre membership. The distribution of the nuclear skill communities between pipeline and cadre, as shown in Table 3, indicates the size of the training pipeline needed to support the skilled cadre, given past attrition and retention rates.

Phase 2: Measuring Pipeline and Cadre Flows

In Phase 1, reliable criteria for identifying nuclear community personnel were established. The application of these criteria to past data made it possible to determine the size of the community, revealing an underlying stability in the distribution of nuclear community personnel to ratings and providing findings about the characteristics of the pipeline and cadre. On the basis of these findings, Phase 2 determined whether historical personnel flows into and through nuclear communities were measurable. There were two sets of questions addressed in Phase 2:

1. Were prospective pipeline members identifiable before they entered the pipeline? That is, were they tagged in some way upon entry into the Navy? When did entry into the pipeline occur compared to entry into the Navy?

2. Did all cadre members enter the cadre through the pipeline, or is there another means of achieving cadre membership? Is there any gap in time between completing the pipeline and entering the cadre?

To investigate these issues, the relevant personnel were tracked backward to determine their personnel characteristics. These analyses were supplemented, when necessary, by forwarding trackings of well-defined subgroups.

The special program code (SPC) data element was investigated as a possible early indicator of nuclear community affiliation. The SPC is intended to specify the program for which personnel are recruited, or to which they are channeled during recruit training. It is entered on each person's first data record and remains the same whether or not the person stays with that program. One of the possible values the SPC field can take is a code corresponding to the nuclear community (SPC = NUC). Its effectiveness as an early identifier of prospective nuclear pipeline members was investigated by tracking backward the nuclear pipeline members who entered the Navy in FY78-81 to determine their SPCs on their first records (see Table 4). Of those who ultimately entered the nuclear pipeline, 94-97 percent had an SPC indicating nuclear community affiliation. These results are somewhat biased because the available data were truncated after the fourth quarter of FY81. Thus, the 96 and 97 percent observed among FY80 and FY81 accessions may be reduced as time passes and as more members have the opportunity to enter the pipeline from other sources.

The SPC can be used effectively as a nuclear pipeline identifier only if consistent proportions of accessions having SPC = NUC flow into the pipeline each year. To check this, accessions having SPC = NUC entering in fiscal years 78-81 were tracked forward to determine the proportions who ultimately entered the pipeline. As shown in Table 5, an increasingly large number of accessions having SPC = NUC never entered the nuclear pipeline. To test the timing of pipeline entry, a distribution was derived of the number of quarters until the pipeline was entered by FY78-80 accessions having SPC = NUC. The distribution showed that within six quarters of accession, more than 99.8 percent of the members who ultimately entered the pipeline had done so, and that 97-98 percent had done so within two quarters of entry (see Figure 1). Taken together, the results in Tables 4 and 5 and Figure 1 suggest that an SPC indicating nuclear field affiliation is not an effective early identifier of prospective nuclear pipeline members.

Table 3

Percentage of Nuclear Community Personnel in Pipeline and Cadre by Rating and Fiscal Year

Rating	End FY78		End FY79		End FY80		End FY81	
	Pipeline	Cadre	Pipeline	Cadre	Pipeline	Cadre	Pipeline	Cadre
Electronics technician	35.7	64.3	30.7	69.3	30.1	69.9	31.1	68.9
Machinist's mate	31.4	68.6	28.4	71.6	25.9	74.1	29.5	70.5
Electrician's mate	29.3	70.7	27.2	72.8	26.5	73.5	29.2	70.8

Table 4

Distribution of Special Program Code (SPC) Among Nuclear Pipeline Members, FY 78-81

Fiscal Year	Accessions Who Became Pipeline Members	Nuclear SPC		Nonnuclear SPC	
	N	N	%	N	%
78	5,065	4,781	94.4	284	5.6
79	4,526	4,284	94.7	242	5.3
80	5,400	5,212	96.5	188	3.5
81	4,821	4,660	96.7	161	3.3

Table 5

Nuclear Pipeline Membership Among FY 78-81 Accessions Having SPC = NUC

Fiscal Year	Total Accessions With SPC = NUC	Pipeline Members		Nonpipeline Members	
	N	N	%	N	%
78	5,431	4,781	88.0	650	12.0
79	6,078	4,284	70.5	1,794	29.5
80	7,567	5,212	68.9	2,355	31.1
81	7,711	4,660	60.4	3,051	39.6

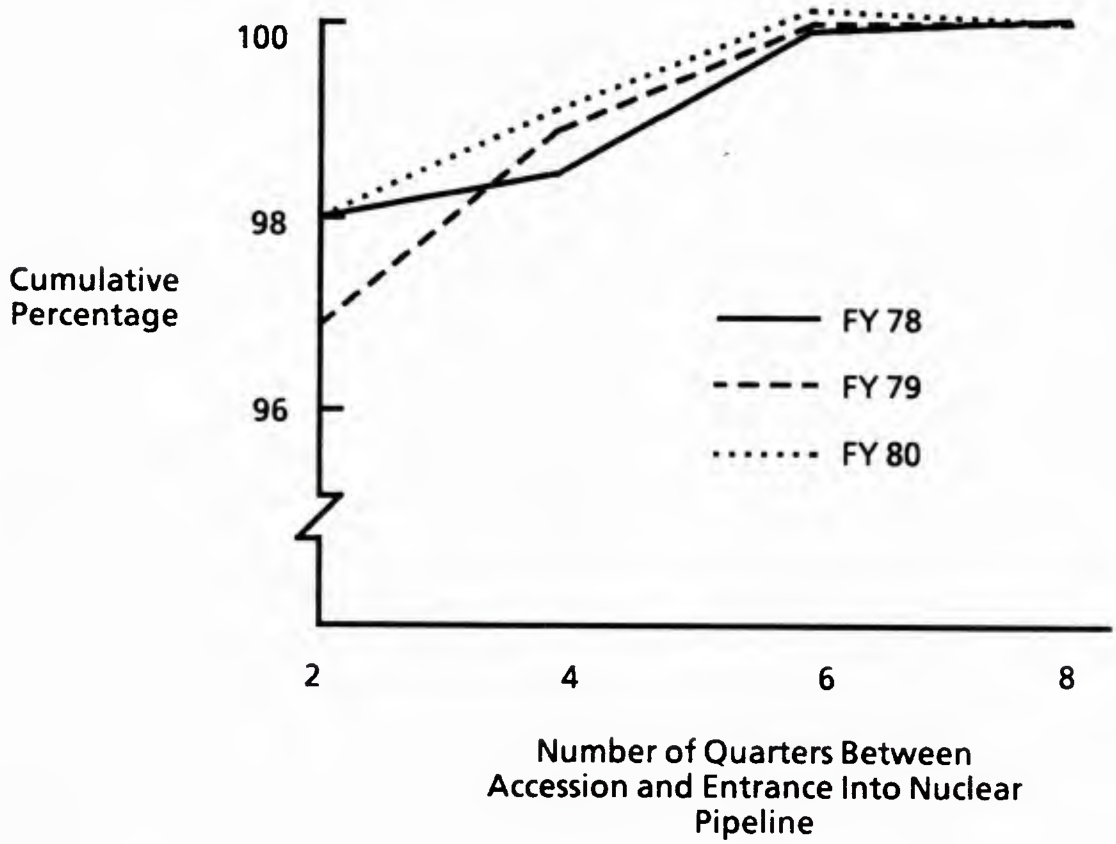

Figure 1. Distribution of quarters until nuclear pipeline is entered by FY 78, 79, and 80 accessions.

The results of these analyses provided the information needed to define cohorts for the purpose of tracking them. Because the percentage of SPC = NUC individuals who enter the pipeline was inconsistent from year to year, it was not meaningful to define a cohort based on SPC. Thus, annual cohorts were defined by their observed pipeline membership. A definition based on actual pipeline membership is valid for fiscal years 80 and 81, because this cohort definition captures essentially all cohort members, even with data truncated after FY81.

To determine whether all cadre members moved through the pipeline, accessions from FY78-80 who ultimately entered the nuclear cadre were tracked backward. As shown in Table 6, the percentage of cadre members who had not come through the pipeline was negligible.

Table 6

Cadre Members Among FY 78-80 Accessions Who Did Not Move Through the Pipeline

Fiscal Year	Entering Cadre[a] N	Not Moving Through Pipeline N	%
78	2,431	8	0.33
79	2,028	6	0.15
80	2,134	3	0.14

[a]As of 30 September 1982.

It was important to identify any gaps in time between pipeline membership and cadre membership so that cohort tracking methodology could be designed to allow for them. Thus, all cadre members were tracked backward from the quarter they entered the cadre to the preceding quarter. In all cases, it was found that in the quarter preceding cadre entrance, the member was in the pipeline (except for those few cases who did not enter the cadre via the pipeline). No gaps in time between pipeline and cadre membership were observed.

Phase 3: Assessing the Stability of Cohort Flow Rates

During Phase 3, annual nuclear accession cohorts were tracked longitudinally to derive flow rates for pipeline losses, strength losses from the pipeline, and pipeline-to-cadre movements. The stability of these flow rates between cohorts was then evaluated to assess the feasibility of mathematically modeling personnel flows within the skill communities.

Given the results of Phase 2, annual cohorts were defined as follows:

- The nuclear cohort for fiscal year t is defined as the set of persons who entered the enlisted force in that year and who, in the quarter of entry or in some later quarter, entered the nuclear pipeline.

- Cohorts were identified for fiscal years 78-81, and their members were tracked to determine their status as of the end of each succeeding year, through FY82 (see Table 7).

The results in Table 7 indicate that within the year of accession, 3.9-6.1 percent of the cohort members have left the pipeline, 1.1-1.8 percent have left the Navy, and 92.1-93.6 percent are still in the pipeline. The percentages contained in the table may be interpreted as flow rates, for example, as rates of flow into the four states from time of entry in the Navy to end of the fiscal year of entry.

By the end of their 2nd year, only 58.2-63.4 percent of the first year's pipeline end strength remained in the pipeline; pipeline losses were 25.4-31.9 percent, and strength losses ranged between 5.4 and 7.0 percent. The proportion of members who made it into the cadre by the end of the second year declined steadily, from 5.8 to 2.8 percent. By the end of the 3rd year, the flows from the pipeline into the cadre ranged between 52.8 and 65.6 percent; the percentage of cadre members who remained members is consistent across cohorts, as are the percentages of cadre losses and strength losses. The end of the 4th year showed some instability in the pipeline rates, partially due to the small numbers still in the pipeline after 3 years. The flow rates among cadre members are very consistent.

Table 7

Distribution of Nuclear Cohort Members by Fiscal Year

Status at End of Fiscal Year	Percentage by Fiscal Year of Cohort 78 (N = 5091)	79 (N = 4544)	80 (N = 5426)	81 (N = 5266)
At End of Fiscal Year of Accession				
Pipeline	93.6	94.5	94.6	92.1
Pipeline loss	5.3	3.9	4.2	6.1
Strength loss	1.1	1.6	1.2	1.8
Cadre	0.0	0.0	0.0	0.0
Total	100.0	100.0	100.0	100.0
At End of 2nd Year (Percentages of Previous End-of-Year Pipeline Totals)				
Pipeline	63.4	60.3	58.2	59.2
Pipeline loss	25.4	28.6	31.9	31.1
Strength loss	5.4	7.0	6.3	6.9
Cadre	5.8	4.1	3.6	2.8
Cadre loss[a]	0.0	0.0	0.0	0.0
Total	100.0	100.0	100.0	100.0
At End of 3rd Year (Percentages of Previous End-of-Year Pipeline and Cadre Totals)				
Members in Pipeline				
Pipeline	16.4	20.4	14.4	
Pipeline loss	18.0	19.5	13.2	
Strength loss (from pipeline)	5.6	5.3	4.9	
Cadre	57.5	52.8	65.5	
Cadre loss	2.5	2.0	2.1	
Total	100.0	100.0	100.0	
Members in Cadre				
Cadre	89.6	87.4	88.8	
Cadre loss	8.2	10.9	8.0	
Strength loss	2.2	1.7	3.2	
Total	100.0	100.0	100.0	
At End of 4th Year (Percentages of Previous End-of-Year Pipeline and Cadre Totals)				
Members in Pipeline				
Pipeline	5.0	1.9		
Pipeline loss	8.4	3.4		
Strength loss	3.8	3.8		
Cadre	80.5	89.6		
Cadre loss	2.3	1.3		
Total	100.0	100.0		
Members in Cadre				
Cadre	92.3	91.9		
Cadre loss	4.7	5.0		
Strength loss	3.0	3.1		
Total	100.0	100.0		

Note. "Pipeline loss" refers to persons who have left the pipeline, but remain in the Navy. "Strength loss" refers to those who have left the Navy. "Cadre loss" from the pipeline refers to persons who have moved into the cadre and then out of the cadre (but stayed in the Navy) since the end of the preceding year.

[a]Less than 0.05%.

CONCLUSIONS

Nuclear-affiliated personnel are identifiable, and personnel movements into and through the nuclear training pipeline, as well as the nuclear cadre, are measurable over time. The high degree of stability in flow rates observed between cohorts indicates that the development of an inventory projection model for nuclear NEC communities is feasible. In a broader context, the results of this investigation provide an approach for modeling closed-loop communities in general. The success of this approach depends on the quality of data describing the flow of NEC cohorts through the pipeline and cadre. Given sufficient data quality, modeling success also depends on the stability of flow rates.

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